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Optical Punched Card: The Symbol of Impending Photonics Age

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Introduction

Everyone of us at some stage of our childhood must have held a big lens (better known as magnifying glass) against the sun to concentrate its energy on to a piece of paper to burn holes in it as illustrated in fig. 1. What we didn't realise then is that we are, in fact, creating an optical punched card (OPC) that stores information which can be retrieved at a later time. That such a thing is possible should not come as a surprise, if we recollect the

methodology of making and using the familiar Hollerith (or IBM) punched card of the bygone years. It is estimated that the area information density of such a mechanically created punched card is a few bits/cm². But the modern-day OPC can yield an information capacity of 10¹¹ bits/cm² or more under suitable conditions. In this article we shall present the concepts underlying the making of modern OPC's.

Laser Replaces Sun

The piece of paper used in the experiment of burning holes using sun light as shown in fig. 1 can be made to accommodate more number of holes

per unit area by exposing it to the extremely tiny focal spots that can be derived using a suitable laser source. Hence one can say, as a rule of thumb, that more bits of information can be stored using laser light than with ordinary light. This is possible due to the fact that laser light is more coherent than ordinary light. It is the aspect of laser light to yield fantastically small focal spots that can be used profitably to make an OPC using, of course, a suitable photosensitive medium as the storage medium.

OPC based on the technique of photochemical hole burning

If the spatial domain of a planar recording medium (i.e., the XY plane) is considered for burning what can be termed spatial holes, then, the area density of such holes will naturally be limited by the constraints of light diffraction and resolving power. But such limitations can be overcome by considering another dimension of light viz., the frequency. In other words, we can have the frequency of light as an additional parameter, besides the spatial dimensions, to encode information and store it. That is why such an information storage is also called frequency domain storage (FDS).

The basic principle underlying the FDS technique is illustrated in fig. 2.

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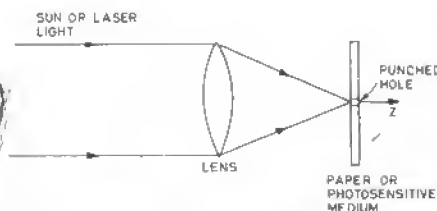


FIGURE 1 DIAGRAM ILLUSTRATING THE PRINCIPLE OF OPTICAL PUNCHED CARD

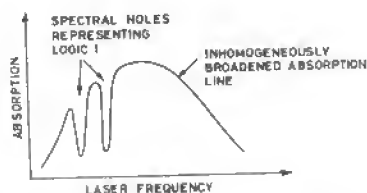


FIGURE 2 DIAGRAM ILLUSTRATING THE PRINCIPLE OF MAKING AN OPTICAL PUNCHED CARD USING THE TECHNIQUE OF PHOTOCHEMICAL HOLE BURNING.

The recording medium consists of some molecular type photosensitive species embedded in a solid host matrix (e.g., color centers in an alkali halide crystal (1)). Because of embedding the inherently narrow absorption line of the photoactive species will become broadened to yield what is known as an inhomogeneously broadened line as shown in fig. 2. Such a broadened line can be utilized to drill, as it were, spectral holes using an appropriate tunable frequency laser (e.g., a diode laser). Thus, at each spatial location of the medium several spectral holes — with each hole corresponding to logic 1 — can be drilled. Since such holes can be derived through the agency of photochemical interactions involving the photoactive species and laser light, such holes are designated photochemical holes; and the technique itself is called photochemical hole burning (PHB) (2). It is intuitively clear that in order to get a useful information store (or memory) the drilled spectral holes shouldn't get erased automatically when the writing light is switched off. The monitoring of the presence or absence of spectral holes, again using laser light of reduced intensity, naturally, constitutes the step of reading the stored information. And by wiping out the spectral holes through some means (e.g., heating or some such endeavour) the stored information can be erased. Thus, with the PHB technique one can make WRITE-READ-ERASE type optical memories. Since the spectral

holes have to persist even after removal of the light the technique is also referred to as persistent spectral hole burning (2).

Active research programmes in the PHB area are ongoing in Canada, USA, USSR, Germany, and Japan in view of its immense potential, not only in the development of high density optical memories but also in the domain of high resolution spectroscopy.

It is easy now to comprehend that the above mentioned PHB based recording medium is in fact an OPC. To appreciate its information holding capability let us look at a model calculation. Suppose we consider an illuminated area of $1 \mu\text{m}^2$ on the surface of the planar recording medium. It means we are considering an area of 10^{-8} cm^2 . It is believed that in a such small area 10^3 spectral holes (of the type shown schematically as logic 1 in fig. 2) can be drilled. Let each hole be a seat for a bit of information, which means an area information density of $10^3/10^{-8} = 10^{11}$ bits/ cm^2 can be realized. What a fantastic capacity compared to the conventional semiconductor and magnetic technology based memories? Exercising a bit of imagination one can see as to how PHB memories of larger capacities can also be realized. For example, if each spectral hole is made

the seat of a page or block of bits instead of one bit, then, with a block of 10^4 bits per page an area information capacity of 10^{15} bits/ cm^2 can be realized. Further, using volume type recording media and holographic techniques in conjunction with PHB technique, it appears possible to realize information densities in excess of 10^{20} bits/ cm^3 . Thus, breathtaking advances in optical memory technologies (involving, for example, such developments as OPC's) are waiting to be harnessed for coping up with the contemporary phenomenon of information explosion. Judging from the unfolding scenario in the realm of photonics, it appears that the day is not far when each molecule in a solid can be made the seat of a holographic page of information and each chemical bond an interconnect (3).

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Awareness of Pollution for Healthy Living*

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Health, apart from hereditary impairments, consists of two components: (1) Physical health and (2) Mental health. Coordination between the two helps for wholesome individual. Physical health depends on (1) The right type

of food and water, i.e., balanced amount of proteins, carbohydrates, vitamins, minerals etc., and (2) The quality of food, water and air. Mental health depends on a *positive* approach to life, calmness and *understanding*. Pollution of any of these factors leads to upset in the chemistry of the vital

* Based on a Radio Talk

processes in our body, leading to slow disease and death. It is therefore important we know and recognise the various pollutions that can occur, then right steps can be taken to avoid pollution.

(1) Air pollution: This is caused by exhaust from automobiles, factory emissions and waste decomposition.

The pollutants are: Carbon monoxide, Carbon dioxide, Nitrogen oxides, Sulphur oxide, particulate matter such as fine dust, silica and carbon, spores and pollen from plants.

Impairment caused: These, if present in the air, in amounts more than known to be safe, cause headache, nausea and respiratory troubles. Carbon monoxide enters the lungs and is absorbed by the blood instead of the oxygen and thus less oxygen reaches the different organs of the body, leading to weakness and tiredness.

The presence of carbon dioxide also decreases the amount of oxygen intake. Sulphur dioxide in presence of water forms sulphurous acid which burns the lung and nasal tissues leading to burning, irritation and cough. The particulates or excessive fine dust get lodged in the lungs and give rise to silicosis that will lead to secondary diseases like pneumonia, tuberculosis and asthma. The pollens also cause allergy and asthma. Constant exposure to pollutants means lack of oxygen to the cells of the body. This will lead to impairment and later non-function. So disease and death follow.

(2) Water pollution: This is caused by factory effluents, agricultural waste run off, human waste and decay of solid waste dumps.

The pollutants released by these are:

(1) Human waste gives rise to microbial and virus contaminations leading to pathogenic diseases such as gastroenteritis, cholera, dysentery, typhoid, tapeworms, infective hepatitis, etc.

(2) Industrial effluents have organic solvents, detergents and metal ions and counter anions. These cause ill health due to absorption of these in our chemical factory and upset the chemical balance. For example, the organic solvents get into the liver for disposal and therefore overwork it. Similarly, the kidney is to overfunction to throw out the non-essentials. This leads to kidney and liver disorders. Next, the metal ions in excess, in water, combine with the enzymes in our system and make them useless. Our food digestion and metabolism is dependent on these enzymes. So the whole body function goes out of gear in presence of these pollutants and the body gets ill health which upsets our normal living. Persistent pollution leads to death.

(3) Food pollution: The use of fertilizers, pesticides, weedicides, are essential for growing food to feed millions of our population. Excessive use of these leads to poisoning of the land. Small doses of insecticides, kill insects but not humans or animals. If this dosage is increased, then it affects man and beast. Most insecticides are neurotoxins, i.e., they affect the nervous system. Excess of this in our food will naturally give rise to all nervous disorders and paralysis.

It is important to note that our body has a great capacity to neutralise the effects of various pollutants and excrete it out as long as it is within its capability. Example, a little salt is essential in our diet but a handful of salt taken at a stretch leads to vomiting. If, on the other hand, a small excess of salt is taken continuously, then the kidney goes on overworking to excrete the extra salt and with time wears out and you end up with kidney trouble and blood pressure.

Thus, it is essential that we keep our air, water and food clean as we consume 15 kg of air, 2 kg of water and 1.5 kg of food per day. We should be

aware of its quality by regular monitoring.

In modern times, this is easy with instruments. Only man has to take the trouble of monitoring. The argument that in olden days nobody did this and they were healthy. Yes, then man did not throw so much waste into the environment and the environment had the time to recycle the waste. Now, more and more is pushed by the increased population in its increased activity. So, it is essential we take care before we fall ill and suffer bodily and mentally. In addition to pollution of air, water and food, we have other pollutants that we must be aware of. They are

(1) **Noise:** Industrial noise, automobile noise or walkman player noise can cause deafness if it is more than 90 db (db – decibels – a unit for noise measurement). Monitoring noise is easy and such environments where excessive noise is prevalent, should be monitored. Noise also causes mental irritation which then leads to blood pressure, heart diseases, mental diseases, lack of concentration and digestive troubles leading to headache and nausea. Even though you ignore noise, the body cannot tolerate noise and therefore it hardens the linings of the hearing mechanism leading to deafness. So be aware of the noise in your surroundings either at home or work.

(2) **Radiation:** a) Protect eyes from excessive light and flickering light. Watching television is quite common, so is the use of television panels in work or for play. The light on a television screen is of flickering type and therefore you must keep at a distance of 6–10 ft or have antiglare screens while viewing and secondly do not view in the dark as in a movie theatre. On the movie screen you have steady light and can be safely viewed. Here you should have a light in the room to counter the flickering light, by dispersion. (b) Welders should also protect their eyes by wearing goggles.

In work environment or TV panel reading the amount of light can be monitored.

(3) *Smoking and tobacco chewing*: It is an established fact that tobacco has cancer causing chemicals. The time it takes to cause depends on the individual's sensitivity to the chemical. A few may escape its lethality but most people suffer from lung and mouth cancer at some time or other depending on the amount consumed, state of health and age. Liver and kidney may also be affected as they are detoxifying and excreting organs respectively. It is healthier to avoid it.

(4) *Alcohol*: This should be consumed as a drug. Alcohol, after consumption, is excreted after being detoxified by the liver. Larger amounts impose heavy work on liver and lead to its impairment. Finally, death takes over after much suffering. Here also the dose that affects depends on the sensitivity of the individual, state of health and age. Therefore, it is better to avoid getting into the habit. You certainly face a risk. Small amounts can be tolerated like drugs, but more is lethal. It is just like tickling makes a baby laugh but continuous tickling will kill it. It is important to remember that alcohol is a drug that one can get addicted to. Continuous use should be avoided.

(5) *Indoor pollution*: The use of more and more synthetic organic materials is going into house construction and furnishings. These materials breathe out very small amounts of organic molecules into the atmosphere. If proper ventilation is not provided (perhaps due to closing of windows and doors to keep off cold, dust and noise) these can increase in concentration and cause discomfort to the dweller. The common symptoms would be tiredness, weakness, headache, nausea, restlessness, asthma and liver upsets. The air in closed or air conditioned rooms, factories needs

monitoring. At home, enjoy fresh air by opening windows and diluting off the pollutants.

Summarising, it is an established fact that pollutants impair the health of the individual be they physical or chemical. The approximate concentration at which this occurs has been worked out and literature is growing. Therefore, without running away from the fact, or being unduly worried about it, we should face things squarely, establish a watch dog committee to watch out for the lapses of the Environmental Board, the industrial hygienist or for ignorance of

individuals. Through this, the exciting and comfort gained technological advance can be enjoyed with a gay abandon since the safety of the well being of the person is assured. This can be achieved by public awareness to pollution hazards, monitoring and control measures being fully practiced both by the producer and user. A knowledgeable society protects itself and lives in harmony with nature. The citizens should therefore take care of themselves and their environment for their own well being. Know thyself and nature and be harmoniously natural. •

On Valuing our Birds: Philosophy or Science

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"If a bird's nest happens to be before you along the way ... with the mother sitting on the young or on the eggs, you shall surely not take the mother with the young; you shall surely let the mother go and take the young for yourself, that it may be well with you and that you may prolong your days". (Deuteronomy 22: 6-7, The Bible, 1400 BC). Now that is a noteworthy statement, possibly the first time ever a law was laid down to restrict man from excessive exploitation of a natural resource, such as birds. 'That it may be well with you and that you may prolong your days' was a strong warning to any ancient Hebrew who believed that he must preserve his breed, the breed from which the world was to have its Messiah and today it is no less a warning to the world that wishes to sustain itself.

Charles Darwin's theory of Natural Selection, as first put forth in 1859, suggests that extinction is inevitable. His statement, "... as new forms are continually and slowly being produced, unless we believe that the number of specific forms goes on perpetually and

almost indefinitely increasing, numbers inevitably must become extinct", has been the basis for counter arguments to conservation. The commonest of such arguments is that extinction is a perfectly natural evolutionary process, one that has gone on for millions of years with or without human participation. Why worry if we are just helping nature take her course? Another philosophy with its roots in religion, suggests that the earth with all its life forms is head on to a total crash. Earth with all its beings is sinful and cursed - doomed to perish! Such anticonservationistic ideas are quite prevalent in our societies. Therefore in what follows, I discuss issues such as (1) Why birds are to be conserved? (2) Whether all birds should be valued equal? and (3) How do we make rational policies on bird conservation?

Scientists and philosophers have been trying to put forth the view that the life forms have values, hence be preserved. However, they differ between them. Scientists value a life form, may be a bird, by what it has to

offer — offer us, directly or indirectly. For example, the sunbirds which may be pollinating the plants that support our life on earth, or some flycatchers and drongos that destroy a lot of insect pests that damage our crops. They value birds such as the junglefowl for their potential to directly serve as food for the humans or as hardy genetic stocks that can be used to improve the quality of our domestic poultry breeds. The recent argument that all birds may have some not yet discovered potential that we may in the future learn to tap and that they serve as natural tools in scientific education and quest, is often brought out as attributes in valuing birds. These so-called values have been considered as 'demand values'. In other words, values based on how much benefits humans can reap from birds.

Philosophy, on the other hand, argues that birds must be preserved because they have an 'intrinsic value'. It is the value birds have which is not dependent on their contribution to the welfare of another form of life. A form of bird has to be protected for its own sake. It has a right to live!

Philosopher Bryan G. Norton, in his book 'Why Preserve Natural Variety' introduces the idea that life forms have a 'transformative value'. In his words, "an object (life form) has transformative as opposed to demand value, if it provides an occasion for examining or altering a felt preference rather than simply satisfying it". To illustrate this, let me quote the paradigm that he himself has used. "Suppose an adult comes upon a child playing in the woods. The child is gleefully destroying eggs from the nests of ground birds. The adult gently explains to the child that eggs are necessary to hatch baby birds and shows the child baby birds in another nest. The child is fascinated, watches the baby birds being fed by the mother, and loses interest in his destructive game. Now he begins to show solicitous

concern for the welfare of birds and asks many questions. Eventually, he grows up to be an amateur ornithologist, deriving untold pleasure from a lifetime interest in birds. The initial appeal of the destructive felt preference and the demand value represented has now been transformed"

The progress of biological conservation efforts, I am afraid, is being slowed down not only by the anti-conservationistic ideas but also by debates as to whether the life forms have to be preserved primarily for their demand values or for their own sakes. Many conservation biologists, a little hesitant to take criticisms on their conservation policies (branded as primarily anthropocentric), are trying to make compromises by allowing philosophic views to permeate into what could otherwise be rational policies. If it is known for sure that indiscriminate destruction of other life forms, not just birds, endangers our survival on earth, our right efforts to preserve nature is inevitable. That anthropocentrism is the root of any conservation effort is something not to be guilty of. The philosophy of preserving life forms for their intrinsic values can be safely ignored unless we are willing to preserve the AIDS virus for its own sake! Would the world that seems to laugh at the gospel of brotherhood and love, take Norton's gospel of Transformation. I wonder! If nature can transform the world view of human beings, so do music, art and moralistic fables. Think about the common scene of hungry children gathered around a roadside garbage bin, gleaning scraps of wasted food. How far have we been transformed seeing it? How much food is wasted in our daily lives!

When we talk about conservation values of birds, there always arises the question, 'How do we value birds?' When I first spoke on conservation values of birds, someone asked me if I meant a kind of bartering. "How many

children can we allow to starve in order that a hornbill be saved?" I recall what a leading conservation biologist once said. Addressing a group of very concerned ecologists on issues of conservation, she stated that if she and her child were stranded on an island and if she saw her child starving, she would kill and feed her child with the animal within her reach even if it were the last of the most endangered animal on earth. I guess anyone would do that. Valuing birds against human beings is the last thing any conservationist will do. Efforts to value birds against the cost and benefits of a proposed hydroelectric project such as the proposed Silent Valley project would also be in vain. Values of birds can not be expressed in any currency. Even if someone did it, it is highly unlikely that it can be anywhere close to reality. What then is the answer?

Birds have to be valued against each other. It is here the question whether all birds be valued equal arises. If I left the choice to you which of these two birds will you value higher: the crow or the peafowl? The peafowl is our National bird. It has a very special place in Hindu mythology. Oil extracted from its fat is supposed to have medicinal qualities. More than all, it is one of the most handsome birds in the whole world. But what of the crow? Who needs the crow? It is so abundant and a practical nuisance wherever seen. Is this how we value birds?

No. Since we do not know the hidden values in most of our birds and because we want to save all the existing birds, conservation biologists are working on systems of assigning priority values to all birds. Priority values are based on the urgency required in saving some forms of birds as compared to the others. Analysis of the characteristics of the birds which have recently gone extinct and those facing the threat of extinction over the world, has shown that the birds were

those found in very small geographic ranges/habitat specialists. They were in small numbers. Some were persecuted by man and his domestic introductions viz., dogs, cats and pigs. Large body size/low reproductive rates and/or being higher up in the food chain was the disadvantage in some others. Having ecological linkages with other life forms marked the fate of a few. Combinations of more than one of these characteristics in birds can have unfavourable consequences. Having known this, the highest priority values must be assigned to such ill-fated birds while making conservation policies.

Simple conservation values can be assigned to these birds. For example, the Nilgiri laughing thrush, a form of bird found only in the Nilgiri hills should be valued higher than the cattle egret which is found all over the world. Birds like the great Indian hornbill which are found only in tall humid forests should be valued more than those like the jungle crow which are found practically in every kind of habitat. The geographic scale used for such valuing can be either global or national. Since we have complete checklists of birds for the world as well as for the Indian subcontinent with details of habitat preferences and geographic ranges, such valuing is not difficult. However, since we do not have precise estimates of populations for most of the birds, values based on population sizes can not be assigned to all birds alike. Values based on the other characteristics can be summed up and expressed as values for their relative degree of endangerment. The more endangered a form of bird is, the more value it gets. It is possible to assign similar values by a form's taxonomic uniqueness. In other words, it may be called genetic value. For example, families represented by single forms of birds such as the crab plover family can be assigned more value, than the crow family with as

many as sixty five specific forms of birds. This system of valuing is consistent and also minimizes subjectivity.

Once all the forms of birds in the country or a state or district have been valued as above, it becomes simpler to identify areas with the most valuable birds in immediate need of conservation. Secondly, when there is controversy over a locality, as to whether it should be preserved for birds or given off for a developmental project, this system of valuing is very effective for the reason that a few localities can be quickly compared, and based on whether the locality in debate is better

for its birds than all the others, rational decisions can be made.

Human beings are self preservative. We must admit it without pretences. Philosophic and moralistic ideas can not be effective in bringing about conservation of birds. For any rational human being, a scientific reason for conserving birds appeals more than philosophy and moral. Science predicts that continued loss of birds may eventually boomerang on us. Therefore let me conclude by saying, "preserve the birds that it may be well with you and that you may prolong your days". •

Machine Translation of Indian Languages

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Artificial Intelligence is the study of how to make computers do things at which, at moment, people are better. Some of the things that the machines can do better are numerical computation which can be very fast and accurate, huge amounts of information storage in its memory, and its capability to repeat the operations any number of times precisely. But people have traditionally outperformed computers in activities which involve 'intelligence' and 'common sense'. So work is on to make the computers 'intelligent' and serve the mankind in a better and effective way.

One of the main goals of Artificial Intelligence is to communicate with the computer in 'Natural Language', such as English. Natural Language Processing (NLP) deals with making the computer understand 'Natural Language Sentences'. Machine Translation (MT) is a sub field of NLP to translate text from one language to the other.

Why Machine Translation?

Work of Machine Translation has now spanned almost four decades. The great effort put into this field is largely because of, firstly, for the need for human understanding of languages unknown to him and, secondly, of course, machine understanding of human languages. Thirdly, the Machine Translation can be used in Information Acquisition (like intelligence gathering by mass media) and Information Dissemination (like technology export). There are large volumes of data and works, both literary and technical, the translation of which becomes tedious and expensive by human translators.

Machine Translation has been done from Japanese, French and other European languages to English, and vice-versa; and from one European language to another. In India, the problem takes vast proportions. The diversity in Indian languages makes one Indian difficult to communicate with another (unless he learns the

other language). Though Hindi and English are the National and International Languages respectively, not everyone knows Hindi or English. Nowadays state vernaculars are being implemented as Official languages of their states. In a country where there are more than 20 regional languages and over 300 dialects, Machine translation from one Indian language to English and viceversa; or from one Indian language to another is of great importance. Several efforts have been made elsewhere in the world, but in India, Machine Translation is still in its infancy.

Brief History of Machine Translation

Early in the history of computers, several attempts were made to use the Machine Translation techniques to translate text from one language to another. It was assumed that if the computer had access to lexical and syntactic information about two different languages, it would not be difficult to translate text from one language to the other. But this approach to Machine Translation failed dismally. The best known example of the failure of this simplistic translation attempt was a translation of this sentence from English to Russian —

(The spirit is willing, but the flesh is weak.)

When the resulting Russian sentence was translated back into English, it gave as —

(The vodka is good, but the meat is rotten.)

The unsuccessful early attempts at Machine Translation failed because, the researchers assumed that one could translate without first understanding. Current Machine Translation research combines the techniques of Natural Language Understanding and Natural Language Generation to try to ensure that the text is translated more intelligently.

Machine Translation work being done elsewhere

Work on Machine Translation is being carried out in United States of America by private fundings, and in Europe and Japan by Government fundings. In Europe a Research and Development project, named 'Eurotra', a 25 million dollar project is being conducted at 15 universities in eight countries. The presence of many languages in a relatively small area tend to increase the demand for such systems, and this project aims to produce a reasonably high-quality translations of written texts for any or all seven official community languages viz., Danish, Dutch, English, French, German, Greek and Italian. In Japan the Agency of Science and Technology of the Japanese Government is supporting the Japanese to English Machine Translation project. In Japan, the Nippon Telegram and Telephone Corporation has demonstrated an experimental system to translate between English and Japanese.

In India

In India, an attempt is made at Indian Institute of Technology, Kanpur in this regard. I.I.T., Madras has recently announced that it has developed a software to use Indian languages to program the computers. Indian Institute of Science is also involved actively and is successful in developing an experimental Machine Translation software.

Difference between English and Indian Languages

Machine Translation between two Indian languages differs considerably from English due to the great difference of linguistic structures between the two. Some of the typical characteristics of Indian languages as compared to English are as follows:

- (i) The word-order is relatively free in Indian languages as compared to English.
- (ii) Nouns, Pronouns and Verbs in Indian languages are either inflected or have post-position semantic markers (case grammar).
- (iii) Adjectives are inflected when used predicatively, but not when used attributively.
- (iv) Verbs are inflected for tense, person, gender and number and they must match with the subject.
- (v) There are three genders in English; where as there are two (as in Hindi and Marathi), or three (as in Kannada), or four (as in Tamil) genders in Indian languages.
- (vi) In Indian languages, some inanimate objects are considered either masculine or feminine such as in Hindi.

Approach to Machine Translation at IISc

In European Communities' project 'Eurotra', the basic design is that of 'transfer system', which consists of three phases viz., analysis, transfer and generation. Japanese approach is also similar. In the work at I.I.T. Kanpur, the analysis phase is based on Panini's formalization of Sanskrit Grammar, in particular, the 'Karaka' structure.

The approach at IISc is the technique developed known as 'Non-deterministic Backtracking Parser', also popularly known as 'Augmented Transition Network' (ATN) parser, which splits the sentence into various parts like Noun Phrase (NP), Verb Phrase (VP) and Preposition Phrase (PP). The parser checks the sentence and its various grammatical components with the standard rules of grammar and a dictionary of words provided in the form of tables. If everything is found correct, the

sentence is declared as 'syntactically correct'. After this phase is over, appropriate rules are applied to extract the root words, noting down the gender-marker, tense-marker and number etc. In addition to the dictionary of root-words for each language, the corresponding case-endings and other semantic details are stored in the form of table. After picking up the equivalent words from the target language dictionary, the corresponding case-endings are added to the root-words in the target language. Then words are arranged in the proper order, without much difficulties, as the word-order being almost same as that of source language (because both of them are Indian languages). This resulting sentence will be in romanized form (i.e., say translated Hindi sentence written in English Script). These sentences are converted into the respective language using the 'transliteration facility' provided with word-processors. The result is the translation of source language text to the target language, and it takes hardly half a second or so. One example paragraph of 'computer output' translation is given below:

New Delhi is the capital of India. It is on the bank of river Yamuna. It is a historical city.

हिन्दी अनुवाद:

नई दिल्ली भारत की राजधानी है। वह यमुना नदी के किनारे है। वह एक ऐतिहासिक शहर है।

ಕನ್ನಡ ಅನುವಾದ :

ನವ ದೆಹಲಿಯು ಭಾರತದ ರಾಜಧಾನಿಯಾಗಿದೆ. ಅದು ಯಮುನಾ ನದಿಯ ದಡದ ಮೇಲಿದೆ. ಅದು ಐತಿಹಾಸಿಕ ನಗರವಾಗಿದೆ.

Conclusion

The days are not far when one can start using computers in his/her own language. When most of the works in almost all fields are computerised for effective handling of jobs, Machine Translation seems absolutely essential for interstate communications, especially in dealing with Government transactions. Machine Translation is expected to take on within few years on a large scale in all fields of related activities.

Scientific Quotation

"A legitimate conflict between science and religion cannot exist . . . science without religion is lame, religion without science is blind"

— Einstein

HIGHLIGHT OF THE NEXT ISSUE

Eighth Plan: Some Strategic Perspectives

-- Abid Hussain

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WEEKLY CALENDAR OF EVENTS		AUGUST 21-27, 1989
Wednesday 23 August	3.00 PM	Molecular Biophysics Unit 'PROTEIN HYDRATION AND STRUCTURAL PERTURBATIONS CRYSTAL STRUCTURE OF LOW HUMIDITY TETRAGONAL LYSOZYME AT 2.1Å RESOLUTION' By Prof.M.Vijayan, MBU (MBU Seminar Hall).
	3.00 PM	Centre for Ecological Sciences 'A CONSERVATION STRATEGY FOR THE BIRDS OF THE UTTARA KANNADA DISTRICT' By Mr.R.J. <u>Ranjit Daniels</u> , CES (CES Seminar Hall)

The information for the next issue between Aug.28-Sept.3, '89
should reach the Institute Calendar, CTS on or before 23.8.89
before 3.00 PM.